

VISUAL ANTICIPATION TIME DIFFERENCES BETWEEN ATHLETES IN OPEN AND CLOSED SKILLS SPORTS

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Abstract

The ability to anticipate accurately and consistently plays a vital role to excel in sports performance. The present study was designed to determine the differences of visual anticipation time between athletes in open and closed skills sports. A total of 95 junior athletes, aged 13 to 16 years old (Mean age=14.84±1.04 years) from Bukit Jalil Sports School participated in the study. Participants were distributed to open skills (n=47) and closed skills (n=48) sports according to their sports environment. Visual anticipation time was tested using Bassin Anticipation Timer in response to stimuli at the speed of 5, 10, and 15 mph, measuring absolute and variable error. Absolute error measured the accuracy of responses while variable error focused on the consistency of responses. The results of this investigation showed that in general open skills sport are not superior over anticipation ability in relations to accuracy and consistency as compared to closed skills sports across all speeds ($p < 0.05$). The evidence from this study suggested more emphasis on training related to eye and hand coordination would be imperative for open skills sports athletes to enhance in on-field sports performance. This study could serve as a base for future studies focusing on visual and hand coordination related to speed as anticipation has been proven to be the key leading to superior performance and for talent identification purposes. Future research concentrating on elite athletes as well as focused sports group would provide further insights on anticipation ability of athletes.

Keywords: Anticipation ability, open skills, closed skills, sports, visual anticipation time

Introduction

Sports can be classified according to sports skills, environment, technique, type, the intensity of exercise, and danger from the collision (Galligan, 2000; Mitchell, Haskell, Snell, & Van Camp, 2005). However, the most commonly used term adapted for sports classification relates to sports skills and environment, which are mainly represented by open and closed skills (Brady, 1996; Ong, Omar-Fauzee, & Choosakul, 2010). Open skills sports involve athletes performing under unpredictable situation in an externally paced environment, where different movements need to be adapted to respond to dynamically changing targets and distances. On the other hand, closed skills sports refer to repetitive movements in an internal environment with a predictable situation (Nuri, Shadmehr, Ghotbi, & Attarbashi Moghadam, 2013; Wang et al., 2013). Examples of open skills sports are badminton, basketball, and tennis while closed skills sports generally comprise swimming, gymnastics, and shooting (Galligan, 2000). Nevertheless, there are numerous factors such as skill, physical and psychological attributes; opponents, and coaches that contribute to successful sports performance in athletes. The fundamental skill speculated to attribute to superior sports performance was anticipation ability, hence leading to the notion of it being used as one of the criteria for talent identification as well (Ripoll & Latiri, 1997; Williams, 2000).

Visual anticipation time (VAT) refers to the anticipation of the moment a moving object arrives at a particular point in space and response to coincide with the moment of an object on arrival (Magill, 1998; Payne, 1986).

This perceptual-motor ability involves the visual system with hand or limb coordination, which is crucial for externally paced sports. This is particularly true in open skills sports such as badminton, squash, hockey, and football which encompass many uncertainties during play (Singer, Cauraugh, Chen, Steinberg, & Frehlich, 1996). Depending on the sports involved, each is characterized by different target sizes, speed, as well as the expertise needed. Anticipation plays a major role in sports with an opponent as it enables the athletes to predict and respond accurately to a fast and dynamic target. Preliminary work on anticipation timing suggested that anticipation tends to be earlier when there is slower velocity of response and later when the velocity becomes faster (Coker, 2005; Williams, 2000). The accuracy of responses, however, increases with increasing velocity.

A considerable amount of literature has been published on age (Benguigui & Ripoll, 1998; Vanttinen, Blomqvist, Luhtanen, & Hakkinen, 2010), gender (Millsagle, 2004; Sanders & Sinclair, 2011), skill levels (Lyons, Al-Nakeeb, & Nevill, 2008; Tenenbaum, Sar-El, & Bar-Eli, 2000), and sports type (Ak & Koçak, 2010; Akpinar, Devrilmez, & Kirazci, 2012), however literatures is still lacking in relation of VAT to the sporting environment. Researchers found higher accuracy and consistency in anticipation ability depending on the sports involved. For example, badminton players had higher accuracy in moderate velocity in comparison to tennis and table tennis which performed better at low and high speeds respectively (Akpinar et al., 2012). The amount and type of training provided within the sports environment affects the anticipation ability of athletes. To the authors' best knowledge, only one study has compared anticipation timing between open and closed skills. Brady (1996) reported open skills athletes have higher accuracy and less variability in responses even at faster speeds as compared to closed skills. Therefore, this study aimed to investigate the effect of visual anticipation time in open and closed skills sports. The study hypothesized that VAT in open skills sports is more accurate and consistent than in closed skills sports.

Methodology

Participants

This cross-sectional study involved a total of 95 junior athletes, aged between 13 to 16 years old (mean age = 14.84 ± 1.04 years), recruited from Bukit Jalil Sports School, Kuala Lumpur, Malaysia. The participants were allocated based on their sports environment; namely open skills (47 participants) and closed skills (48 participants) sports. Open skills sports involved ball sports such as badminton, squash, hockey, and football. Closed skills sports consisted of junior athletes participating in athletic, taekwando, gymnastic, diving, wushu, gymrama, shooting, and swimming sports. Participants had good ocular health with no recent history of ocular pathology, medication or systemic diseases. Prior to the study, all participants and parental consent were attained and complied with the tenets of Declaration of Helsinki. Ethical approval was given by Universiti Kebangsaan Malaysia Research Ethical Committee: UKM 1.21.3/244/NN-081-2013.

Procedures

All participants were required to undergo thorough visual and perceptual assessment. Visual assessments comprised of refraction, colour vision (Ishihara colour vision plates) and hand dominancy. The refractive errors of all participants were corrected to optimal visual acuity (LogMAR acuity 0.0 or equivalent Snellen acuity 6/6). These visual assessments were imperative to ensure participants obtained optimal vision before conducting the perceptual assessment.

Perceptual assessment involving VAT were measured utilizing a linear runway Bassin Anticipation Timer (Model 35575), Lafayette Instruments Co., USA at stimulus speeds of 5, 10, and 15 mph in line with previous studies (Chen et al., 2009; Durey & Seydel, 1994; Iino & Kojima, 2009). The apparatus simulates a moving stimulus by having a series of lights lit sequentially on a runway which consists of three 16-lamp runways attached end to end and mounted securely to a table top. The total length of the apparatus is 2.29 m. Each section of the track has 16 LED lights 10 mm in sized spaced 4.47 cm apart. The runway was connected to the handheld response button with a depress trigger for the athletes to response. Participants were required to make a motor response using the index finger of their preferred writing hand to depress the trigger. The examination was conducted with binocularly optimal correction and at an eye-level with the Bassin Anticipation Timer at a distance of 2 m. Participants were presented with three trials at each speed for familiarization on the test protocol. A standardized procedure of VAT examination was explained before initiation of the tests.

Measurements

Anticipation time was measured as the difference between the time when the visual stimulus arrived at the target location and the moment participant presses the hand-held response pushbutton. A digital timer indicating the amount of milliseconds (ms) and direction (early or late) of the error after each trial would be recorded. Late response and early response from the actual point were recorded as positive and negative respectively.

The accuracy of performance in motor behavior could be measured by errors made since it is inversely related to accuracy (Ives, 2013). Highly skilled performers generate little or no errors in their movement. The common error scores used in measuring accuracy of movement involved were absolute error (AE) and variable error (VE). The AE represented the magnitude of error, which is calculated by total subtraction of criterion score from raw score and divided by the number of trials. The VE indicated participant's constancy of response, which is derived from the standard deviation of AE score.

Statistical analysis/analyses

The magnitude of errors was calculated and expressed as mean and standard deviation. The normality data were tested using Shapiro-Wilk as the subjects are less than 100. Unpaired student t-test was used to compare differences between open and closed skills sports for AE and VE. To further understand the effect of speed on AE and VE, one-way repeated measure analysis of variance (ANOVA) was performed. Statistical significance was set at $p < 0.05$.

Results

The mean binocular visual acuity for open skills sports was LogMAR 0.00 ± 0.06 while for closed skills sports it was LogMAR 0.01 ± 0.05 . The data obtained for both groups were found to follow a normal distribution and variance hence parametric tests were used to analyze the data. An unpaired t-test was conducted to compare the VAT between open skills and closed skills sports across the speed of 5, 10, and 15 mph. There were no significant differences in the absolute and variable errors across the speed of 5, 10 and 15 mph between open and closed skills sports. These results indicate that open skills sports were not superior in anticipation ability when compared with closed skills sports. Means, standard deviations, and t-values for VAT were displayed in Table 1.

Table 1: Visual Anticipation Time for Open and Closed Skills Sports

Visual Anticipation Time	Open Skill Sports (Mean \pm SD)	Closed Skill Sports (Mean \pm SD)	t	p-value
Absolute error (ms)				
5 mph	85.64 \pm 43.30	94.38 \pm 39.30	-1.03	0.31
10 mph	45.76 \pm 41.28	42.51 \pm 17.06	0.50	0.62
15 mph	75.07 \pm 37.25	72.48 \pm 23.27	0.41	0.69
Variable error (ms)				
5 mph	85.44 \pm 84.17	118.48 \pm 91.76	-1.83	0.07
10 mph	102.40 \pm 133.26	89.84 \pm 61.90	0.59	0.56
15 mph	176.10 \pm 104.09	162.98 \pm 81.97	0.68	0.50

A repeated measure ANOVA was used to investigate the effect of speed on absolute and variable error as a measure of anticipation ability. However, Mauchly's test indicated that the assumption of sphericity had been violated for absolute error, $\chi^2(2) = 7.06$, $p = 0.03$, therefore degrees of freedom were corrected using Huynh-Feldt estimates of sphericity. The results show that there were significant effect of speed on absolute error, $F(1.92, 178.51) = 50.40$, $p < 0.001$, partial $\eta^2 = 0.23$ (Figure 1).

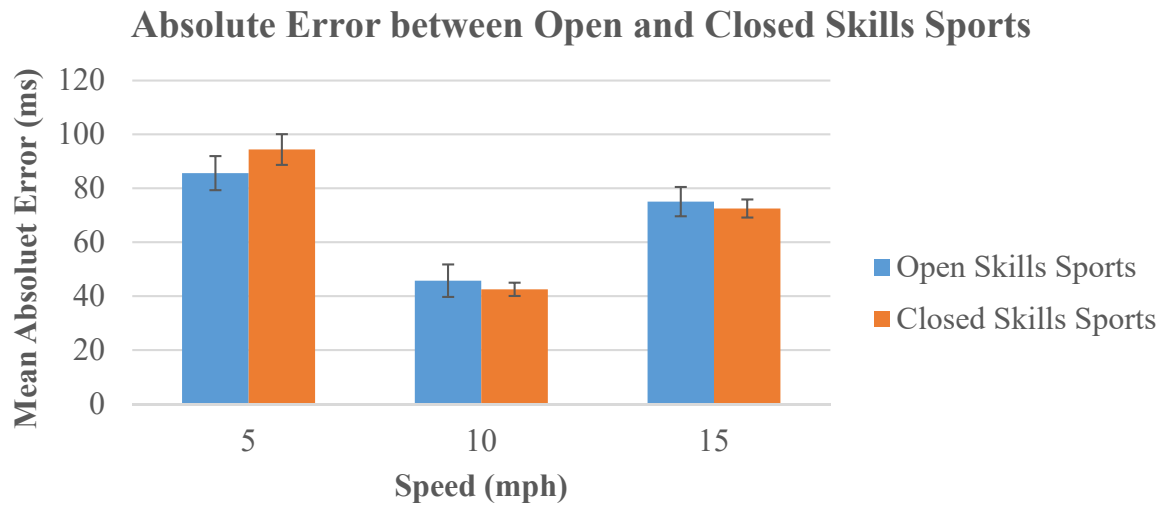


Figure 1: Comparison of absolute error between open and closed skills sports

For variable error, Mauchly’s test indicated that the assumption of sphericity was not violated, $\chi^2(2) = 0.99, p = 0.79$, therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity, $F(1.99, 185.07) = 19.09, p < 0.001$, partial $\eta^2 = 0.17$, indicating speed affects variable error (Figure 2).

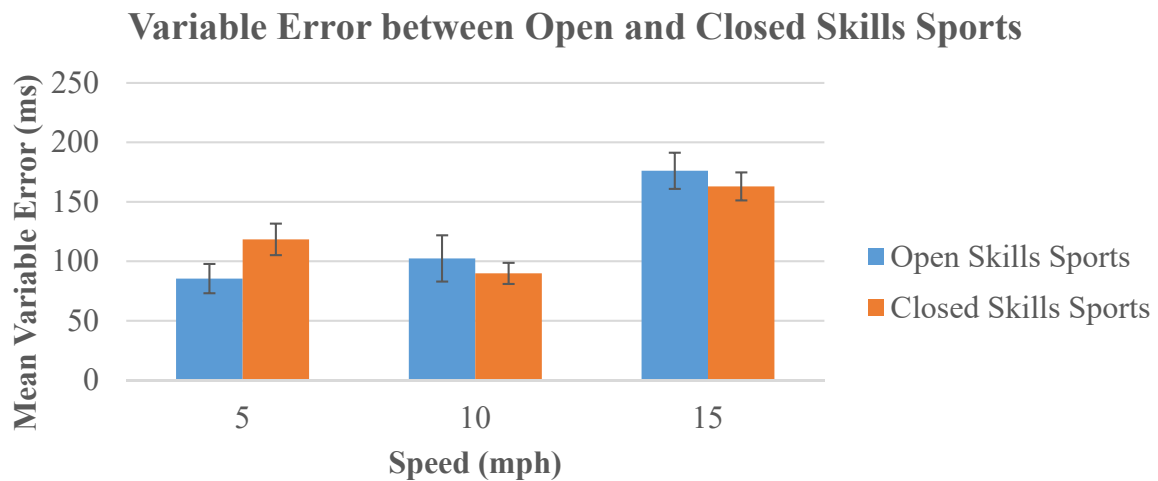


Figure 2: Comparison of variable error between open and closed skills sports

Post-hoc tests for anticipation errors on open and closed skills sports were done using the Bonferroni correction. The results for AE was statistically significant ($p < 0.001$) across all 3 speed conditions. These results suggest that speed does influence the magnitude of errors in the sports of this study. However, post-hoc analyses for VE was unable to show any significance at the speeds, 5 and 10 mph, for open and closed skills sports ($p > 0.05$). Nevertheless, it was found statistically significant ($p < 0.001$) for both open and closed skills sports at the speeds 10 to 15 mph. Specifically, our results suggest that the athlete’s consistency falls when the speed of play increases.”

Discussion

Very little was found in the literature on the anticipation ability of open and closed skills sports, with the general expectation that athletes in open skills sports would have been superior in anticipation ability as compared to those involved in closed skills sports. These expectations may be from the idea that open skills sports are usually comprising of a target, opponent, and the training or play environment, requiring a much

faster response to excel in on-field performance. Therefore, the present study was designed to determine the difference in anticipation ability between open and closed skills sports.

Contrary to expectations, this study did not find significant differences in anticipation ability of open skills sports compared to closed skills. Only at the speed of 5 mph, did athletes in open skills sports have a higher accuracy and consistency; however, this was inconsistent with the accuracy and consistency at the speeds of 10 and 15 mph respectively. As a result, the findings of the current study do not support the previous research (Brady, 1996) that open skills sports are more accurate and less variable in faster speeds as compared to closed skills sports. It seems possible that these results differ from the previous study due to differences in participant's skill level and experience as the participants in Brady (1996) study were all elite athletes as opposed to our study which mostly involved sub-elite or junior athletes. Also, there is a possibility that our results may have been affected by the sensory-cognitive skills related to each sport as described by Nuri et al. (2013).

The results from speed on anticipation error suggested that magnitude of error increases as speed increases, suggesting the influence of velocity on anticipation ability. However, the effect of speed on sporting environment did not influence the anticipation errors. The combination of these findings provides an important criterion to be considered prior to initiating a study for anticipation. Careful consideration should be given to the sports' characteristics as each sport has a different target and speed timing (Akpınar et al., 2012). The findings were unexpected and suggested that athletes in closed skills sport performed with higher accuracy and consistency at higher speeds as compared to open skills sports. Although the findings were statistically insignificant, this suggests a possibility of a lack in decision-making and in training which involves simultaneous visual and motor performance in a dynamic environment, especially for the junior athletes.

Vision plays a fundamental role in athlete's performance especially in areas of visual search, selective attention, and anticipation (Kluka, 1999). Therefore, more emphasis in training related to eye and hand coordination with decision-making skills would be necessary for open skills sports athletes to excel during competitions. Studies have suggested that improvements in anticipation ability can be obtained from visual training using the temporal occlusion method with the use of vision occlusion spectacles (Farrow & Abernethy, 2002; Müller & Abernethy, 2014). The absence of statistical differences in our study may also be associated with a small sample size and a broader sports group coverage in closed skills sports that could have vast differences in their training environments. Nevertheless, this study could contribute to the current body of literature to provide baseline information for athletes in both open and closed skills sports, which would enable coaches to understand the anticipation ability of their athletes better before developing or modifying their training modules for these athletes. Thus, it can be surmised that anticipation ability is an important factor to take into consideration, especially in the open skills sports for excellent on-field performance.

Conclusion

This study was set out to determine VAT differences between athletes in open and closed skills sports. Returning to the hypothesis posed at the beginning of the study, it is now possible to state that athletes in open skills sports have similar accuracy and consistency as compared to closed skills. Although results were contrary to previous studies, the evidence from this study highlighted the need for visual training to improve anticipation ability of athletes especially in a dynamic environment to enhance sports performance. Further research in specific sports with a larger sample size, involving elite athletes would be of great help in creating a deeper understand on the effect of anticipation to sports.

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